6. On the Anatomy of a Grebe (*Æchmophorus major*), with Remarks upon the Classification of some of the Schizognathous Birds. By Frank E. Beddard, M.A., F.R.S., Prosector to the Society.

[Received March 17, 1896.]

As so few of the Grebes have been dissected, I took the opportunity offered, by the death some months since of a specimen of *Æchmophorus major*, to make some notes upon the principal viscera and muscles, which I now lay before the Society.

As is well known, birds differ very much in the extent of a horizontal membrane which is attached laterally to the oblique septa and posteriorly and ventrally to the abdominal wall. This membrane has been variously termed "Omentum," "Pseudepiploon," and "Horizontal septum." When the abdominal viscera of the Grebe are exposed by cutting carefully through the body-wall at some distance behind the sternum, the cavity which contains them is seen to contain only the intestines. As is the case with many other birds, with many Passeres for instance, the duodenal loop is very extensive, reaching right to the end of the abdominal cavity. This cavity, containing the intestines, is shut off from the anterior part of the abdominal cavity by an almost vertical septum, which is the reduced equivalent of the horizontal septum. This septum cuts off from the intestinal cavity another cavity which incloses the gizzard and the liver, and is again divided into right and left halves by the falciform ligament. The right cavity thus formed contains as usual only the right lobe of the liver. I should mention also, as a fact of some systematic importance, that neither the gizzard nor the entire extent of the liver is sheltered by the sternum; they lie nearly altogether behind it. In this particular *Æchmophorus* differs from *Psophia*, *Cariama*, and the Rallidæ; but the Grebe agrees with those birds as well as with the Ducks in the small extent of the horizontal septum.

§ *Myology.*

I have only made notes upon the more important muscles from a classificatory point of view.

The arrangement of the tendons of the *tensores patagii* is characteristic. The tensor brevis is early divided into two separate tendons which run down the patagium to be inserted as usual on to the forearm. They do not, however, as in the majority of birds, form well-defined narrow tendons, but are thin and ill-defined sheets of tendon. The division which lies nearest to the humerus is particularly thin and difficult to delimit. The outer band has a thickened strand on the side nearest to the humerus; it thins off gradually on the outer side. The nerve to the hand passes under

the inner tendinous band and the thickened inner strand of the outer band, but above the rest of the tendon. The tensor longus tendon, as usual, dilates at the middle of the patagium into a yellowish thickened nodule of different appearance from the rest of the tendon. From this, or from its immediate neighbourhood, arise a few strands of tendinous tissue arranged in a fan-like fashion, which become collected into a thin tendon running obliquely across the patagium to be inserted on to the tendon of the extensor metacarpi. One of the thin strands which make up the patagial fan is directly continuous with the biceps slip. The muscle in fact appears to end in this tendon, and not to be inserted, as is more usually the case, into the tendon of the tensor longus.

The *biceps* is less fleshy than this muscle often is. The tendons of origin and insertion are continued over the greater part of the muscle as superficial tendinous sheets. The muscle has practically only one head of origin, that from the coracoid; there is, however, what I believe to be the remains of the humeral head in the shape of an attachment to the under surface of the pectoralis major.

The *deltoid* has an insertion upon the humerus of no great extent. It is attached to that bone for rather less than a third of its length.

The *anconæus* has a humeral head which is a somewhat narrow tendon arising close to the insertion of the latissimus dorsi.

The *expansor secundariorum* appeared to be totally absent.

The *pectoralis major* is rather a thin muscle; it is, however, for a portion of its extent divisible into two layers. The superior margin of the muscle, *i. e.* that furthest away from the carina sterni, is largely tendinous. The insertion of the muscle on to the crest of the humerus is tendinous throughout for about the last eighth of an inch.

The *pectoralis minor* is, as usual, a bipinnate muscle, but the lower side is much wider than the upper. Its origin from the sternum and the carina extends rather more than halfway down.

The *latissimus dorsi* is as usual divided into two muscles, with a branch going to the skin (not always present in birds). This is the dorso-cutaneous of Fürbringer. The last mentioned overlaps the entire origin of the posterior half of the muscle and is continuous with the origin of the anterior.

The *glutæus maximus* consists of two separate parts. In front of the acetabulum is a not very wide ($\frac{1}{4}$ inch) strap-shaped band about the same size as the sartorius, which it partly overlaps. From the acetabulum to the very end of the ilium arises a sheet of muscle which completely covers the underlying biceps, and is inserted on to the fascia covering the leg from the knee to nearly halfway down.

The *glutæus medius* is incompletely divided into two halves. They run side by side, and are inserted each by a separate tendon of insertion which are connected by a muscular part.

The *glutæus minimus* is completely hidden by the last muscle; it is small and entirely fleshy and arises from the ilium only.

The *biceps* is large and fleshy, about an inch across at its origin. The tendinous sling through which it passes to its insertion is formed of two strong ligaments attached to the femur; one of them is identical with the head of the gastrocnemius. In addition to these two, there is a broad coarsely fibrous band running from the bottom of the loop to one of the flexors of the foot.

The *ambiens*, the *femorocaudal*, and the *accessory semitendinosus* are absent.

The *accessory femorocaudal* is a thin muscle tendinous at both origin and insertion.

The *semitendinosus* and the *semimembranosus* appear to form one intimately conjoined muscle, which gives off before its insertion a very delicate tendinous slip to the gastrocnemius.

Only one *peroneus* is present in *Æchmophorus*. The origin of this overlaps that of the tibialis anticus. The tendon in which it ends is inserted into the mass of fibro-cartilage at the ankle through which the flexor tendons bore their way.

The *tibialis anticus* has a tendon which is bifid at its insertion; just in front of the point at which the tendon divides, a tendinous slip is given off which runs for some way down the foot and is finally fixed to skin.

The *extensor communis digitorum* divides into three tendons for the toes. That supplying digit II. remains a single tendon. The tendon supplying digit III. divides into three separate tendons; while the tendon supplying digit IV. divides into two.

The *gastrocnemius* has the usual three heads. The inner is much the largest, and its origin commences at the very summit of the great cnemial crest of the tibia and extends halfway down the leg. The outer head arises, as has been already mentioned, in common with the tendinous sling of the biceps. These two heads end in tendons at precisely the same level below. Shortly after this (about $\frac{1}{2}$ inch) they join. The third head arises in common with the tendinous insertion of the outer of the two adductors; its tendon (ossified) joins that of the inner head some way in front of the junction of the inner and outer heads.

Flexores perforati.—There are the usual three muscles supplying the three digits. Their tendons are not connected with each other, or with the tendons of the flexor perforatus et perforans, in any way.

Flexor perforatus et perforans.—Only one digit (III.) is supplied by this. The tendons of the flexor profundus digitorum and of the flexor longus hallucis are intimately fused for a considerable length. From the conjoined tendon no slip is given off to the hallux. Each of the other digits has its own slip. The tendon supplying digit II. arises first; then the remaining part of the tendon divides into two, each half supplying digits III. and IV.

§ *Comparison of* Æchmophorus *with other Colymbi.*

My information as to the myology of other Grebes is derived

from the works of Garrod[1], Fürbringer[2], and Gadow[3], and from my own dissection of *Podicipes cristatus*. These observations only refer to various species of *Podicipes* (*P. cornutus*, *P. cristatus*, *P. minor*, *P. novæ hollandiæ*). The differences between these forms and *Æchmophorus* are not great. The tendons of the tensor brevis are, however, a little different, judging from the figure which Fürbringer (*loc. cit.* pl. xix. fig. 4) gives of *Podicipes cornutus*. In that Grebe the tendon of the *brevis* and the recurrent tendon, the *longus*, appear to form a continuous sheet of tendon covering a good deal of the patagium. In *P. cristatus* the biceps slip joins the *brevis* tendon. The biceps is two-headed in some other Grebes, but single in *P. cristatus*. The *expansor secundariorum* is not entirely absent in other Grebes, but is rudimentary. I did not look for it with a microscope in *Æchmophorus*, so there may be a faint rudiment. I could not find one, however, in *P. cristatus*.

The syrinx of *Æchmophorus* (fig. 1) has a very incomplete bronchidesmus, a very wide space between the two bronchi existing above its anterior edge. The last two tracheal rings are fused to form a long box, into the composition of which it appears to me that the first bronchial semiring enters. In any case, if that be not

Fig. 1. Fig. 2.

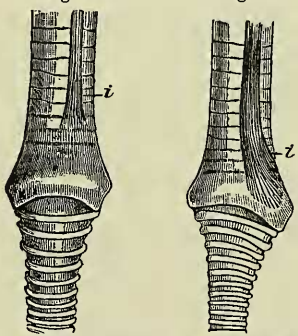


Fig. 1.—Syrinx of *Æchmophorus*: *i*, intrinsic muscles.
Fig. 2.—Syrinx of *Tachybaptes*: *i*, intrinsic muscles.

so, the first bronchial semiring has the unusual relations shown in the drawing, which are perfectly consistent with the belief that the ring is the second bronchial. The intrinsic muscles are attached to the third tracheal ring in front of the tracheo-bronchial box. The

[1] Collected papers *passim*.
[2] 'Untersuchungen zur Morph. u. Syst. der Vögel.'
[3] "Aves" in Bronn's 'Thier-Reich.'

bronchial semirings are fairly ossified, but have rather wide membranous interspaces.

In *Podicipes cristatus* there is the same failure of the intrinsic syringeal muscles to reach even the end of the trachea. A box is formed by fusion at the end of the trachea, into which it appears to me the first bronchial semiring does not enter. The bronchial semirings are deeper and closer together, and the whole bronchus is more ossified, than in the last genus. The bronchi, too, are longer.

In *Podicipes coronatus* the syrinx is much the same, but of course smaller. The first free semiring of the bronchus seems to be No. 2. There is a wider membranous interval between it and the antecedent tracheo-bronchial box than in the last species.

Tachybaptes fluviatilis (fig. 2, p. 541) has a different syrinx. The last three tracheal rings are only fused in front, though they are closely united laterally. These rings are much ossified. The insertion of the intrinsic muscles is remarkable. They run obliquely forward, converging, to be inserted into the last three tracheal rings. The first bronchial semiring is arched, and ossified in front where it is fused with the tracheal box; otherwise it and the succeeding rings are cartilaginous. It is clear, therefore, that the syringeal characters justify the generic distinction here adopted.

§ *On the inter-relationships of Podicipedidæ, Laridæ, and Alcidæ.*

By some, *e.g.* by Mr. Sclater, the Grebes and the Auks are referred to one order. By others, *e. g.* by Dr. Gadow, the Laridæ are placed in the immediate neighbourhood of the Auks, both being separated from the Grebes and Loons. In preparing a general treatise upon the Anatomy of Birds, upon which I am now engaged, I have had to go into this matter. I propose to give now such new facts as I have ascertained for myself, and extracted from the note-books of Mr. Garrod and Mr. Forbes, which bear upon this question.

It appears to me to be quite necessary to separate more widely the Alcidæ from the Laridæ, than the Laridæ from the Charadriidæ (s. l.). Dr. Gadow, in the classificatory part of his account of the Birds in Bronn's 'Thier-Reich,' does not define the Lari by one single character of importance that distinguishes them from all of the remaining Limicolæ. Nor are any such characters forthcoming from the elaborate tables of Prof. Fürbringer. In attempting to justify the separation of some such group as the Longipennes, I have, on the contrary, found additional evidence for a closer union between the Gulls and the Plovers. I should regard the former, in fact, as merely forming a family of Dr. Gadow's Limicolæ, equivalent, for instance, to Chionididæ, Œdicnemidæ, &c. And this family will have to be defined wholly by external characters.

I imagined for some time that the remarkable condition of the *biceps brachii* in the Gulls would prove a fact of classificatory value. In Gulls the *biceps* is divided into two distinct muscles, corresponding to the humeral and coracoidal heads of the more normal

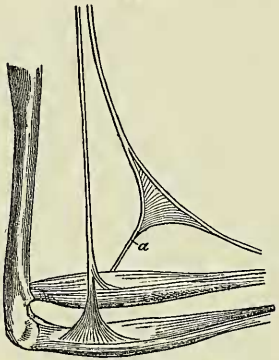
biceps of other birds. The coracoidal part of the muscle again divides into two parts, of which one supplies the radius, and the other the ulna. Dr. Gadow mentions, upon the authority of Meckel, that in *Himantopus* and *Scolopax* the biceps is divided. I find in a specimen of *Himantopus nigricollis* the following arrangement of the several parts of this compound muscle. The muscle has two distinct portions—one, which may perhaps correspond to the entire biceps of other birds, has the two normal heads, one arising from the humerus, the other from the coracoid. In addition to this is a distinct coracoidal portion which has a common origin from the coracoid with the coracoidal half of the double head of the muscle. In *Cursorius* I also found the biceps to be double much in the same way; but the division only commenced a little way below the level of the humeral attachment. Finally, in *Lobivanellus* there were indications merely of the same division by a superficial furrow extending for some way up the muscle.

In the Gulls proper (the *Larinæ* of Howard Saunders) there is a syrinx of a more typical form than in any Limicoline bird known to me. Its more "typical" character consists in the fact that the single pair of intrinsic muscles are attached to the first bronchial semiring, and that that ring is bowed and closely attached to the last of six or seven slightly modified tracheal rings. In the Limicolæ, on the other hand, the intrinsic muscles are frequently absent (*Himantopus*, *Hæmatopus*, *Squatarola*), and when present do not as a rule extend down as far as the bronchi; they end upon a tracheal ring at a variable distance from the end, though in some cases at least they may be continued as far as the bronchi by fibrous tissue. *Lestris*, however, has a syrinx which differs from that of the Gulls in that the intrinsic muscles end at the last tracheal ring, being attached partly to this and partly to the two in front; the muscle, in fact, is inserted rather obliquely. No very distinct line can therefore be drawn between the two groups in the structure of the syrinx.

Some justification for the association of the Laridæ with the Alcidæ is to be found in the disposition of the tendons of the tensor patagii brevis. In the Gulls, as in Limicoline birds generally, the tendon of the brevis muscle is double from the commencement, while the anterior of its two parts gives off just before its attachment a wristward slip from which passes upward obliquely the patagial fan to be inserted on to the tendon of the longus. There is, too, in both groups invariably a biceps slip, which may be inferred from Prof. Fürbringer's statement: as, however, I am acquainted, from my own dissections and from the sketches left by my two predecessors, with a larger series of both Laridæ and Limicolæ than were known to Dr. Fürbringer, the fact seems to be worth emphasizing. In *Larus argentatus* there is, as is shown by a sketch of Mr. Forbes's, a peculiar tendinous slip passing from the tendon of the longus patagii to the flexor side of the forearm, which is quite distinct from the patagial fan already referred to. This has not been observed in any Limicoline birds but *Charadrius pluvialis*; it is highly characteristic of the Alcidæ. It may therefore be useful to

reproduce one or two of the late Mr. Forbes's sketches in illustration of the tensores of those birds, which have been but little described. The simplest form perhaps is to be seen in *Synthliborhamphus antiquus*. Here (fig. 3) there is but one tendon to the

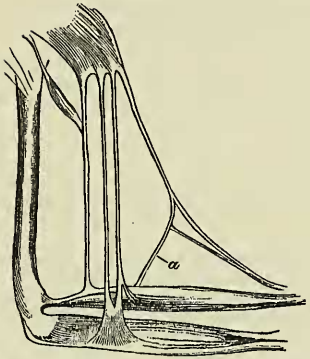
Fig. 3.



Tensores patagii of *Synthliborhamphus antiquus*.
a, slip to ulnar side of forearm.
(From a MS. sketch by the late Mr. Forbes.)

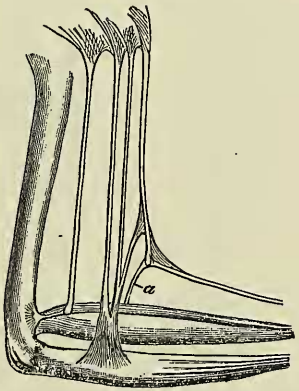
brevis muscle, which is inserted on to the forearm and passes over its muscles to be attached below to the ulna. This single tendon appears to correspond to the anterior of the two invariably present in Gulls and Limicoline birds: this is to be inferred from the fact that it gives off just the merest apology for the wristward branch found in those birds; there is no patagial fan connecting this tendon with the longus tendon; but a thin tendon runs from the longus and is attached to the flexor side of the forearm. Fürbringer's figure of these tendons in *Alca torda* shows no trace of this peculiar slip; but it seems to occur at least in the majority of the Alcidæ. Its presence and the rudimentary character of the wristward branch of the main tendon of the brevis are the special peculiarities of the patagial tendons in the Alcidæ. There are, however, as many as three separate tendons all running parallel in some species. In *Lunda* (see fig. 4), *Ceratorhina* (fig. 5), *Brachyrhamphus*, and *Uria* this is the case. In *Fratercula* and *Alca* there are only two. In a few species (in *Fratercula* for instance) where there is a patagial fan, a small ossicle as in the Petrels is developed. It seems clear, therefore, that the patagial muscles of the Alcidæ do not on the whole favour the close relationship of the Alcidæ to any other Limicoline birds, the resemblance to the Gulls

Fig. 4.



Tensores patagii of *Lunda cirrhata*. *a*, as in fig. 3.
(From a MS. sketch by the late Mr. Forbes.)

Fig. 5.



Tensores patagii of *Ceratorhina monocerata*. *a*, as in fig. 3.
(From a MS. sketch by the late Mr. Forbes.)

and to the Plovers being only seen in one species of each group and in the aberrant *Rhynchops*. There is, moreover, the same amount of likeness to the Limicolæ proper in a small point which may be regarded as of equal importance. The biceps slip, always present in the Alcidæ, has, at least as a rule, rather unusual relations. Thus in *Alca torda* Fürbringer figures it as attached partly to the patagial membrane and partly to the inner of the two brevis tendons. In the Gull the insertion is the more normal one, *i. e.* on to the longus tendon. In *Fratercula arctica* the muscle is inserted upon the middle of the three brevis tendons. Now in a specimen of *Tringa canutus* (doubtless individual variation), I found a second biceps slip in addition to the usual one, which was inserted on to the outer of the two brevis tendons. This tendon I take, for reasons already explained, to correspond to the middle of the three tendons of *Fratercula*.

I have carefully studied the windpipe of a number of Auks, and can find no reasons for associating them especially with the Gulls from an examination of this organ. The syrinx is seen in its most characteristic, even exaggerated, form in *Ceratorhina monocerata*. In this Auk (fig. 6) the first bronchial semiring is the shape of half an ellipse—a gross exaggeration of the generally arched form of this ring in the avian syrinx; the same form is shown by the second bronchial semiring, which lies as it were inside the first

Fig. 6. Fig. 7.

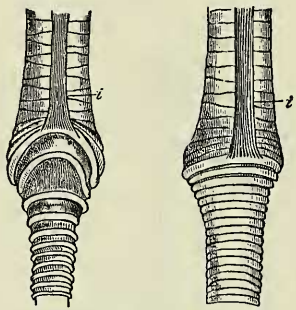


Fig. 6.—Syrinx of *Ceratorhina monocerata*: *i*, intrinsic muscles.
Fig. 7.—Syrinx of *Lomvia troile*: *i*, intrinsic muscles.

and is concentric with it. The intrinsic muscles are attached to the first. Nothing of this kind occurs in any Gull or Limicoline bird known to me. In other Auks, however (fig. 7), the syrinx is decidedly more typical in form. It is an interesting fact that we can arrange the family into two subfamilies according to

the modifications of the syrinx and the muscles of the leg. In *Alca*, *Phaleris*, *Lomvia*, *Uria*, and *Synthliborhamphus* the syrinx does not show the extraordinary modification described in *Ceratorhina* and occurring also in *Lunda* and *Fratercula*. In the three latter genera the ambiens is present, but the accessory femorocaudal is absent. The exactly reversed condition characterizes four of the first mentioned genera[1]. *Uria columbia*, however, has a syrinx which is an approach towards that of the more differentiated types.

May 5, 1896.

Dr. JOHN ANDERSON, F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of April.

The registered additions to the Society's Menagerie during the month of April were 99 in number. Of these, 32 were acquired by presentation, 30 by purchase, 6 were born in the Gardens, 30 were received on deposit and 1 in exchange. The total number of departures during the same period, by death and removals, was 141.

Amongst these attention was called to a young male Indian Elephant (*Elephas indicus*) from Burmah, purchased of Mr. Cross of Liverpool, April 10th[2].

Mr. W. E. Hoyle, M.A., exhibited some photographs of a snake in the act of swallowing a mouse, taken by aid of the Röntgen rays, so that the skeleton tissues of both animals were clearly shown. The snake in question was a common grass-snake (*Tropidonotus natrix*), belonging to Mr. V. H. Sugden, of the Owens College, who kindly superintended that portion of the experiment connected with it. As the snake did not appear hungry, its mouth was opened and the mouse pushed down its throat; when about two-thirds of it had passed between the jaws the first exposure was made, but this failing owing to movement on the part of the snake, ether was administered and complete repose thus secured.

Three exposures were subsequently made—one from above and one from the side,—in which the expansion of the jaws to take in the comparatively large prey was well shown. The third exposure was made when the mouse was completely within the snake's throat, and the contrast between the natural and the distended diameter of the body was very marked. By the kindness of Prof. Schuster, F.R.S., the experiments were made in the Physical Laboratory of the Owens College, and the electric apparatus was superintended by Mr. A. T. Stanton.

[1] *Phaleris* is exceptional in having neither ambiens nor accessory femorocaudal.

[2] This Elephant, on the 4th of June, was found to weigh 11 cwt. 1 qr. 7 lbs.